

FEEDING BEHAVIOUR OF FREE-RANGING RHESUS OF TUGHLAQABAD¹

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Numerous primate studies show food as a key ecological variable, influencing social behaviour and population dynamics. A long term study showed, that although the rhesus of Tughlaqabad spent an average of only 2.34 hours daily, feeding and foraging which constitutes 17.5% of their day time activity, which is rather less as compared to other studies, yet their feeding behaviour affected their many other activities. The Tughlaqabad monkeys consume three types of foods, 1) food provided by humans, 2) natural food in the terrain, 3) agricultural crops. Of the 45 different species of food plants consumed by them, only 24 constituted a significant intake. Of these 24, 9 were leaves, pods and fruits of trees and rest 15 were agricultural crops. 59% on an average, yearly, of their feeding time was spent on food from human and 41% on foraging for natural foods and crops making the results rather unique. The time spent on foraging on a particular day depends upon the availability of food from visitors. It was seen that the activities of rhesus of Tughlaqabad are governed by one major component of the ecosystem namely, the human population. Thus evidently groups modify their feeding behaviour markedly, depending upon specific habitat and environmental conditions.

INTRODUCTION

The purpose of the present study has been to employ quantitative field techniques to study the feeding patterns of the free ranging rhesus population of Tughlaqabad. In the absence of any long term study at Tughlaqabad, the present work has necessarily been exploratory and of a rather general nature. Hopefully, it provides a comprehensive backdrop for future studies that focus on more specific problems and relationships.

Relatively few studies of rhesus feeding behaviour have been done in India, and none in a habitat like Tughlaqabad. Lindburg (1975, 1976) and Neville (1968) studied the food habits of rhesus groups around Dehra Dun and

Haldwani feeding primarily on natural forest vegetation. Siddiqi and Southwick (1980) studied the food habits of roadside groups in an agricultural habitat north of Aligarh. Tughlaqabad offers the most diverse of these habitats in that it contains forest patches, agricultural fields, pastures, and a public archaeological site.

The habitat exerts a profound influence on the successful use of field techniques. There are many advantages of studying this group of monkeys as it is not a confined colony but yet has almost all the advantages of a semi-protected population. Good visibility provides an opportunity to acquire information relating to spatial relations and both interspecific and intraspecific social relations amongst the animals; the presence or absence of territoriality, the extent of home ranges, night sleeping quarters, and utilization of available resources. Since the components of the ecosystem change seasonally, and from year to year, and the

¹ Accepted May 1985.

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weather varies annually, data have been collected during 5800 contact hours over 3 breeding seasons. Such a longitudinal study programme allowed examination of seasonal or other periodic variables and their influences on group activities. This longitudinal study also helped to investigate the influences of various personalities upon critical roles in the group, such as the differences in the diet of different age and sex classes and reasons behind it. Thus an attempt has been made during the study to examine the relations between social organisation and ecology. The techniques used to collect data on various activities and population dynamics of rhesus monkeys of this area were Goodenough's Time Sampling method (1928), Smith's Scan technique (1968) and Sampling all occurrences of some behaviours (Rowell 1967). The population and habitat at Tughlaqabad have been described in previous papers (Malik, Seth and Southwick 1984, 1985).

BACKGROUND

Many primate studies have shown food as a key ecological variable, influencing social behaviour and population dynamics. Both field (Chalmers 1968) and laboratory studies (Zimmerman *et al.* 1973) have demonstrated that a large proportion of aggressive interactions occur as a result of competition for food. Play which requires "surplus" energy, decreases as the amount of available food decreases (Altmann 1959, Loizos 1967). Increased availability of food produces a decrease in day range because the group does not have to travel far to secure sufficient food (Altmann and Altmann 1970, De Vore and Hall 1965, Crook 1966). Hall (1963) postulated that groups which spend less time foraging, spend more time engaging in social activities especially grooming; similar propositions have been advanced by Crook (1970) and Rowell (1972).

Under a constantly abundant food supply, an increase in population size has been noted among the provisioned colonies of Japanese macaques at Takasakiyama (Itani *et al.* 1963, Itani 1975) and the rhesus macaques at Cayo Santiago (Koford 1965b). Conversely, in a food limited population of *Macaca sinica*, the survivorship of infants and juveniles has been reduced, and the population has remained stable (Dittus 1975, 1977). The diversity of food consumed by each primate species has not been evaluated, due in part to great differences in observational opportunities to tally the number of plant and animal species eaten by the group under study (Jolly 1972).

The extent to which animals select a particular food can be estimated by dividing the amount consumed by the availability of the food in that environment (Clutton-Brock and Harvey 1976). Several studies have calculated selection ratios for particular foods by dividing the proportion of time spent feeding on the 'natural vegetation' by some measure of the relative availability/abundance of the vegetation (or, in some cases, the relative abundance of the canopy cover they provide). The larger the cover, the greater the availability of the food (Clutton-Brock and Harvey 1976, Struhsaker and Oates 1975).

Nutritional analysis of diet and the energy costs of activities have only recently begun to figure in primate studies (Coelho 1973). Detailed accounts of feeding behaviour for the 12 or 13 species comprising the genus *Macaca* have been published only for *Macaca sinica* by Hladik and Hladik (1972).

Struhsaker and Oates' (1975) estimates of the time spent consuming different foods by red colobus were very similar to those obtained in the neighbouring troop by Clutton-Brock and Harvey (1976).

Marriot (1978) reported that the rhesus monkeys of Kathmandu spend 10.5% of their

day time in feeding based on a comparative study of the food supplied by humans and the naturally available food. Her main interest was in the type of food eaten, amount consumed and nutritional content of the food. Taylor (1975) observed that the temple monkeys of Kathmandu obtained 68% of their overall diet from worshippers and the remaining 32% from natural sources. Teas (1978) found that feeding changes from being the second most predominant activity in the summer to the most consuming activity in the fall. Shrestha, Malla and Majupuria (1980) reported monkeys eating nettle grass during the solar eclipse in 1980. Feeding behaviour of the rhesus monkeys of Swayambhu (Nepal) have also been studied by Bajracharya (1979).

Macaca mulatta frequently eats earth in small quantities (sometimes taken from termite mounds) (Blanford 1888-91, Roonwal 1956, Mandal 1964, Mukherjee and Gupta 1965, Lindburg 1971, Puget 1971, Krishnan 1972). Drinking behaviour of *Macaca mulatta* in India has also been studied (Mukherjee 1969, Mukherjee and Gupta 1965 and Mandal 1964).

RESULTS

Feeding plays one of the most important roles in determining the daily routine. Although the rhesus of Tughlaqabad did not have to spend long hours in foraging, an average of only 2.34 hours daily constituting 17.5% of the daytime activity, nonetheless their feeding behaviour affected many other activities. The priority of feeding was illustrated by the observation of a mating pair who terminated the bout to obtain food from a visitor. Even after eating, mating was not resumed. The animals sat close for a short while and then went in different direction.

The Tughlaqabad area provides rhesus mon-

keys with a wide range of food. The vegetation found in the area is xerophytic and subtropical. Crops are grown in adjacent fields. The monkeys consume three types of food: (1) food provided by humans, (2) natural food in the terrain, and (3) agricultural crops. The food provided by humans is fairly consistent, almost ritualistic, but it comes in greatest abundance on Tuesdays and Saturdays. This does not change much seasonally; only, as the summer days are longer and daylight hours are more the people have more time to feed the monkeys. Thus the monkeys spend 10% of their time during summer on food given by humans, slightly more than 9% during the winters. The food provided by nature and agriculture varies more seasonally: (1) when crops have been sown and trees bear fruits (January, February), or (2) when crops have been harvested and trees bear no fruit (May and November). In the first instance, when the monkeys have not had enough food provided by man, they fall back upon the natural food. In the second instance, even nature does not provide food in abundances, so they spend more time foraging, i.e., 11% in the month of May as compared to only 6.5% in the months of March, September and December. Thus the dietary pattern is variable and adaptable at different times of the year. The peak of the feeding time on any given day is between 9 A.M. and 11 A.M. during winters and 8:30 A.M. to 10:30 A.M. during summers. This is the period when the animals either are fed by the humans or have waited long enough to be fed by humans, and if they are not fed, resort to the natural vegetation. The other period of equally intense feeding is in the evening between 3 P.M. till 5 P.M. during winters and 4 P.M. during summers.

The rhesus of Tughlaqabad were observed to consume 45 different species of food plants,

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but only 24 of these constituted a significant intake. Of these 24, 9 were leaves, pods and fruits of trees, and 15 were agricultural crops (Table 1). These numbers do not include the

was certainly not as diverse as the forests available to the monkeys in Lindburg's study, where they were observed to eat portions of more than 100 species (Lindburg 1975, 1976).

TABLE 1
NATURAL AND AGRICULTURAL FOODS IN THE TERRAIN

Local Name	Botanical Name	Part Eaten	Energy in Kilo Calories
ON TREES			
Babul (Desi kikar)	<i>Acacia arabica</i>	leaves and pods	
Date Palm (Khajoor)	<i>Phoenix dactylifera</i>	fruit	144 fresh
Gum Tree (Kikar)	<i>Acacia arabica</i>	leaves and pods	
Indian Jujube (Ber)	<i>Zizyphus jujuba</i>	all but the seed	158
Margosa (Neem)	<i>Azadirachta indica</i>	tender leaves	158
Peepal	<i>Ficus religiosa</i>	figs	110
Oak	<i>Quercus incana</i>	fruit	
Siras	—	leaves and pods	—
Sissoo (Shisham)	<i>Dalbergia sissoo</i>	leaves and pods	—
IN FIELDS			
Brinjal	<i>Solanum melongena</i>	leaves & fruits	40 & 24
Cabbage	<i>Brassica oleracea</i>	leaves	27
Cauliflower	<i>Brassica oleracea</i>	leaves & stalk	66
Carrot	<i>Daucus carota</i>	leaves	77
Chari (Jowar)	<i>Sorghum vulgare</i>	leaves	349
Lima beans	<i>Vigna catjang</i>	leaves	290
Maize	<i>Zea mays</i>	grain & leaves	125
Masoor	<i>Raphanus sativus</i>	leaves	28
Methi	<i>Medicago falcata</i>	leaves	—
Mustard	<i>Brassica acampestris</i>	leaves	34
Peas	<i>Pisum sativum</i>	leaves & pods	315
Radish	<i>Raphanus sativus</i>	leaves	28
Spinach	<i>Spinacia oleracea</i>	leaves	26
Turnip	<i>Brassica rapa</i>	leaves	67
Wheat	<i>Triticum aestivum</i>	Grain, stalk & leaves	341

Quantitative food requirements are usually estimated in terms of heat units calories. A physiological calorie (also called Kilocalorie and abbreviated Kcal*) is the amount of heat necessary to raise the temperature of one kilogram of water by one degree centigrade and this heat unit is different from the physical heat unit which is one-thousandth of the physiological calorie. This is an amount of food having an energy-producing value of one large calorie.

* also known as the large calorie.

variety of foodstuffs provided by people which ranged from chapatis to eggs and mutton patties or similar picnic items. The natural vegetation

It was, however, more diverse than the tree species available to the rural monkeys in the study of Siddiqi and Southwick (1980) where

only 4 species of native trees were available in addition to mango and guava.

The Tughlaqabad rhesus spent 41% of their feeding time on natural vegetation on the yearly average, and 59% of their feeding time on food provided by humans (Table 2). This

catching a cockroach, smelling and rejecting it, which was later taken up by a juvenile who also rejected it after smelling. Juveniles are more exploratory with food and acquire new food habits more easily than the adults. At one time a fruit with a hard shell (*Bael-Aegle*

TABLE 2
DISTRIBUTION OF TIME BY ACTIVITY IN DIFFERENT SEASONS

Average	seasons	Eat natural vegetation	Fed by humans	Drink
percentage	Winter	07.30	09.00	02.00
time spent	Summer	08.49	10.00	04.71
per day	Annual	07.99	09.50	03.35
Average	Winter	00.88	01.08	00.24
hours	Summer	01.02	01.20	00.56
per day	Annual	00.96	01.38	00.42

differs from the Chhatari group of Siddiqi and Southwick where only 7% of the feeding time was spent on natural vegetation, 10% on agricultural crops, and 83% on direct handouts from people. In the Sumera Fall rhesus group near Aligarh, however, 53% of the feeding time was on natural vegetation, 17.5% on agricultural crops, and only 29% on food directly from people. Thus rhesus groups seem to modify their feeding behaviour markedly depending upon specific habitat and environmental conditions.

Acquisition of New Food Habits and Adaptability: The rhesus monkeys here wait to get food from the local people or visitors before plundering the vegetation of the area. The Tughlaqabad monkeys' diet is composed of vegetable food, though at times they have been observed scrounging and sucking eggs from food baskets brought there by picnickers. Other than eggs, the rhesus monkeys of all age groups, and both sexes have rejected all types of non-vegetarian food. An adult was observed

marmelos) was cracked by a visitor and thrown in pieces to the rhesus monkeys. The first piece was grabbed by an adult female who smelled the fruit and rejected it. But the rejected piece was taken by a juvenile of about 7 months who ate the fruit after smelling and tasting it. The bael was probably rejected by the adult as she had had enough food and did not want to risk experimentation, or adults are by nature more rigid in their food habits than juveniles.

Acquisition of new food habits are related to the amount of food available at a time. At the time of food scarcity even adults eat the food they had refused to eat at a time when surplus food was available. Supporting this is the instance of a female adult rejecting a mutton patty after sniffing it. When a juvenile tried to pick up the rejected patty it was cuffed by the adult and forced to leave it alone. But approximately two hours later, during which she did not get anything to eat, at a different spot, when the same adult female was given

a patty she sniffed it and tasted the bread and proceeded to eat the bread but rejected it when she reached the meat inside the patty.

The diet of the rhesus monkeys of Tughlaqabad also includes bark, seeds, cereals, fruits, vegetables, leaves, earth and buds. On just one occasion an adult male was seen eating bird droppings. This was the only occasion when such a behaviour was observed.

Posture: The most usual feeding method involves sitting on their haunches conveying the food to their mouth by hand and biting off the desired morsel. The hand engaged while conveying the food is mostly the right hand, though at times they use both hands together or alternatively. When extremely hungry or in danger of being attacked by the others, a rhesus monkey will gobble down the food rapidly. At times when food is plentiful for all, or a rhesus monkey feels safe from attack by others, it will eat the food slowly, seeming to 'relish' each bite. When there is scarcity of food, the monkeys have been observed scraping the inside of banana peels leaving just the thin membrane. A rhesus monkey was observed licking banana from the road where it had been dropped by another.

The other method employed while feeding is to stand on their hind feet, using forepaws to pick food from the ground and conveying it straight to the mouth, alternately with each paw. The feeding can be intense, relaxed or lazy. Intense when they are eating both their favourite foods and are very hungry. Relaxed when there is no threat of any danger and when they may be hungry. Rhesus monkeys of Tughlaqabad have been observed lazily eating wild fruits, grass and leaves.

Processing: The rhesus monkeys have been observed on numerous occasions, dusting the food picked from the ground before it is conveyed to the mouth. This they usually do with food they eat without peeling; for example,

chappatis, bread, biscuits, apples, chikoos, etc. Certain foods need special preparation before being consumed. For instance, the shell surrounding the peanuts is first removed with the incisors and the nut is eaten. The skin of the mango is first peeled with the incisors and the hands and the fleshy pulp is eaten by scraping the fruit with the incisor teeth. The skin of the banana is likewise stripped before being eaten, first half the length, the other half may be discarded or eaten, depending on how full the monkey is.

Rhesus monkeys eat grass blades by plucking them with the right hand and conveying them to the mouth. They break small pods of sheesham by pressing the pod against the teeth with the hand and then consuming them.

Food Preferences: The rhesus eat and relish fruits, which are also eaten by human beings. Bananas are fed most often, hence their fondness for the fruit. But they also eat other fruits like apples, chikoos, and tomatoes with as much fondness as bananas, when given. The second food preference is the food prepared by humans, like chappatis, bread, rusks, biscuits, etc. Lastly, they prefer the wild fruits, leaves, pods and crops of the area.

These preferences are relative: related to the extent of their hunger. On the other hand when they are very hungry and resort to the vegetation of the area for nourishment, they eat the natural food just as intensely as they eat bananas or biscuits.

Interaction with Human Beings: Rhesus monkeys at Tughlaqabad at times greedily pounce upon food even before it is offered to them. At one instance, some visitors had brought bananas for the monkeys in a car. Before the bananas were taken out of the car, monkeys pounced upon the food greedily grabbing as much as they could carry. At other times, they do not come near the man handing out food. And yet at other times, they

are apprehensive to start with, testing the intentions of the giver before they eagerly approach him in swarms demanding their share by tugging at his pant or shirt, and climbing on to him. But will not snatch the food from his hand and will wait for their turn, eager yet not hostile if they know the giver and he is firm. They only threaten visitors who come to give the food if they are threatened first. Pirta (1984) has also described the behaviour of rhesus in taking food from people.

Foraging: Foraging behaviour is affected by age, sex and social rank of the individuals. This is illustrated by the fact that a dominant animal consistently fed to the exclusion of subordinates in those regions where food was most abundant. Subordinate animals often had

animals. All food items and their rates of consumption by these four focal animals were recorded every minute. The individuals were followed from 5.30 A.M. till 7:30 P.M. The data thus collected revealed that dominant males get the maximum calories, followed by the dominant females (Table 3). The lowest or poorest food was consumed by the juvenile females. The subordinate animals approached the food only after the dominants had had their pick of the food while they fed on the leftovers, also the dominants were the first to pounce upon the food given by the visitors.

Use of Buccal Pouches: Buccal pouches are used on two occasions: (1) when there is surplus food and the rhesus monkeys want to store the food to be eaten later. For example, when being fed by human beings and when they do not want to waste time chewing the food,

TABLE 3
FOOD CONSUMPTION IN RELATION TO AGE AND SEX CLASS¹

Age & Sex Class	Bananas	Channa peanuts & other seeds	Chappatis	Leaves, shoots & herbs	Wild fruit	Total calories consumed
Adult male	12	22.5 Gms.	2	—	4	2196
Juvenile male	6	35 Gms.	1	¼ handful	10	1235
Adult female	7	40 Gms.	1	½ handful	25	1449
Juvenile female	4	50 Gms.	¼	1 handful	33	1115

¹ During 14 hrs. of 1 day, from 5:30 a.m. to 7:30 p.m.

their food usurped. In times of general food scarcity when foraging time in all age classes had increased, the order of least time spent but most food consumed, was most marked and evident. Adult males spent the least amount of time in food foraging, then adult females followed by juvenile males. The most time spent in foraging was by juvenile females. As to the quantity, it was not easily observed on a day when food was in abundance, i.e., a Tuesday. On Tuesday, 13th May, 1980, four known active healthy individuals were the focal

the food is gobbled down to fill the buccal pouches to be eaten later at leisure. (2) at a time when there is threat of the food being snatched by the dominants, it is stored in a hurry to be eaten later, e.g., on lean or normal days when visitors offer food to the juveniles, they store it immediately in pouches without looking at the dominant adults around.

Intra-group Relationship While Feeding: The infants are a privileged class in the group. The attitude of the other members of the group towards the infants is one of tolerance. The

male adults tolerate from them what they would not tolerate from juveniles. For instance, while feeding, the leader is the first one to approach to take the food and the one who tries to precede him is severely punished, but not so the infants. An infant, however, may take a morsel even out of its mother's hand and eat. This way the infants learn to recognise the food. Having eaten what the mother eats, the infant learns the taste and smell of the food. The mother would not permit this of an older offspring. For example, when any attempt is made by a juvenile to take the food from the mother, the juvenile is snarled at, but not so the infant. The leader at one instance bit a juvenile on the neck when it tried to take food before he could take food.

Spacing Mechanism: When eating intensely on the food given by humans no spacing mechanism is ever observed. While raiding farms or cultivated plots each individual including the dominant males and females, subordinate males and females, and juveniles eat with a space of 2 or more feet separating them from others. Time to time they look up to survey their surroundings. Anyone violating the empty space has a fight on its hands. Frequent threatening and at times even biting occurs.

Threats: The majority of threats occur during foraging. A threat during foraging has several effects: (i) it prevents an animal from approaching another engaged in foraging, (ii) it causes the respondent to sit still and cease feeding while a dominant feeds nearby, (iii) usually it displaces the subordinate. The usurpation of food by dominants from subordinates is sometimes carried to the extent of snatching it away from its hand. Normally this occurs during a period of general food shortage.

Fights occurring over food do not start in the customary fashion, i.e., with a warning of any sort. Unlike territorial fights where the

monkey threatens, shows its teeth and chest, assumes a very alert stance, etc., fights over food begin abruptly and end likewise. The offender is pounced upon before one knows what has happened. The quickness with which a rhesus monkey will pounce upon food before the leader, tends to save it from punishment and the loss of its food. The difference in getting away with offending the leader and getting caught is the speed with which they move. At one instance, food thrown for the leader was approached by a juvenile whom the leader caught, and bit on the neck. But while the leader was punishing this one, another juvenile hastily took the fruit away. Fights over food are of a very short duration, involving the offender and the offended alone.

There are two consequences of aggression between adults. Either the challenge is taken up and fighting occurs or the threat is ignored, which results in pacification of the aggressor and eventual repose. Fights occurring within a group never involve everyone of the group, but when fighting erupts, for a moment all group members are alarmed, including small infants.

Attitude Towards Senile Female: The senile female that lives among the rhesus monkeys of Group 'A' at Tughlaqabad is totally ignored. She is not threatened but neither is she allowed to feed among the other rhesus monkeys of the same group. She will either wait till all have eaten and then feeds on the leftovers. If a person feeding the monkeys spots her, she is thrown a fruit, but even the fruit especially thrown for her is sometimes grabbed by the others. She herself stays aloof from the others and never tries to compete with the others for food.

Farm Raiding: The rhesus monkeys at Tughlaqabad have ample opportunity to raid cultivated fields. As the fields are situated away from the village it is not possible for the

villagers to protect their plots at all times. The rhesus monkeys usually go into the fields in the evening, usually in large numbers, and at times as many as 120 animals are together in an area of 2-3 acres. It is interesting to note that at the time when this observation was made (1980) there were only two groups in the area and the total membership of the two groups was 120.

While feeding in a cultivated plot, there is no apparent sentinel to watch for impending dangers. The animals, while eating, will look up every few seconds to survey their surroundings. If any animal spots anything threatening it will immediately give a high pitched call to warn the others of the dangers, whereupon they all flee.

While raiding farms, the rhesus monkeys eat wheat by bending the stalks and prying the grain loose, either with their fingers or with their incisors. They will leave only the bare stalk (there is no wastage). At times they even eat the stalk. After a raid at the farm all that remains to be seen is just bare sticks where once there had been wheat.

Recognition of Food: Most rhesus monkeys locate and recognize their food mainly by sight. Odours of ripe fruits attract them occasionally. When they recognize the food by sight they do not smell it, but if food is given that they are not familiar with, they will first sniff it and then proceed to eat it or reject it, depending on their choice. For example, when given a green onion for the first time, it was sniffed by an adult female and only then did she eat it and seemed to enjoy it. In case of a tomato, it was not sniffed but was eaten with the smacking of lips and lingering over it as if to prolong the experience with obvious relish. A piece of candy wrapped in a bright wrapper, when given to a sub-adult male, was first stripped off the wrapper, sniffed and eaten with such relish that he refused a banana

offered later on and was content to just sit where he was and smack his lips. The other members who watched him were tempted and many came down from the trees to examine the wrapper, one even went so far as to put it in his mouth, but spat it out when he realised it had no taste.

Rhesus monkeys not only recognize the food but recognize the visitors as well who have fed them on earlier occasions. Certain cars which come regularly to feed them are instantaneously recognized by these monkeys. It is evident from the fact that even before the vehicle has stopped and the food is offered to them, they start moving towards it in large numbers.

Rhesus monkeys are usually never hostile or afraid of visitors who come to feed them periodically. They will go right up to the person, extend one hand, tug at his pant with the other hand asking for their share. Even when the man stamps the ground with his foot to shake them loose, they do not threaten him but converge upon him again once he starts giving out the food. But sometimes monkeys are apprehensive of strangers who bring food for them.

A oooooonnnhh (sounding like the mewing of a cat) type of call is given by members of the group as soon as they recognize or suspect that food is anticipated, thus informing other members of the arrival of food. On hearing this call the whole group converges upon the vehicle or the people.

Drinking and Water Requirements: Drinking is clearly predictable as there are two sources of water available to them. One is from the leaves and juicy fruits. The second is the direct water source.

During winters most of the water requirements seem to be met by consuming leaves and juicy fruits. Time spent on drinking is only 2%. In summer, because not sufficient

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water is available (for, even natural water sources dry up) they spend more time (4.71%) looking for drinking water. Little direct drinking behaviour was witnessed in the early part of March. However, towards the end of March and from April onwards, direct drinking was observed, and at times, even three or four times a day, each time a majority of the animals drink.

We have seen the rhesus monkeys drinking at all hours of the day. At times, even at 6:00 A.M. shortly after waking up the rhesus monkeys have been observed drinking water. There is no relationship between troop spacing or numbers and availability of water. At times, large groups comprising over hundred animals gathered at one place may space their drinking over a long period, interrupted by bouts of playing and eating. They lean on their forelegs and dip their snouts in water and suck through their lips for 2-3 seconds, lift their heads sharply, look around and then dip

their snouts again if they need more. After one has finished, other rhesus monkeys drink in the same way as the one before.

This is the only method observed while the rhesus drink water. Hands were never used to facilitate drinking water, except on one occasion on 15th April (1980). One adult male used his right hand to clear the water surface at least 5 times before he finally drank water by dipping his mouth the usual way. At times even 10-15 rhesus monkeys have been observed dipping their mouths in water not individually but all at the same time. Rhesus monkeys frequent the village pond, the tubewell, the drain and the well for their requirements of water though they readily drink from rain water puddles when available. At times of acute scarcity rhesus monkeys explore the whole length and breadth of their territory for fresh sources of water, even if it is dirty water collected from construction work (as on 23rd

TABLE 4

DISTRIBUTION OF TIME BY ACTIVITY IN DIFFERENT MONTHS

Months	Eat Natural Vegetation		Fed by Humans		Drink	
	A	B	A	B	A	B
January	00.84	07.00	01.08	09.00	00.18	01.50
February	00.84	07.00	01.08	09.00	00.18	01.50
March	00.78	06.50	01.08	09.00	00.24	02.00
April	01.08	09.00	01.20	10.00	00.69	05.80
May	01.22	11.00	01.20	10.00	00.84	07.00
June	01.14	09.50	01.20	10.00	00.85	07.10
July	00.81	06.80	01.20	10.00	00.78	06.50
August	00.99	07.60	01.20	10.00	00.24	02.00
September	00.78	06.50	01.20	10.00	00.24	02.00
October	01.08	09.00	01.20	09.00	00.30	02.50
November	01.20	10.00	01.08	09.00	00.36	03.00
December	00.78	06.50	01.08	09.00	00.24	02.00

A:— Mean No. of hours/Day

B:— Average percentage Time

April they moved to Adilabad in search of water and had water from a pit at the construction site).

When foraging for water, the leader takes the whole troop but when ample water is available to them in their core area no one leads. The adults get priority over the sub-adults and juveniles if they happen to reach the water hole at the same time. And if the sub-adults and juveniles do try to be the first ones, the adults chase them away with threats and baring of the teeth.

Adults were never observed playing with water, but juveniles and infants have been observed jumping, splashing and swimming, at times chasing each other in or around water. On one occasion the mother patted her young infant (2-3 weeks old) as a signal to move, thus discouraging it from fooling around with water. Juveniles and adolescents were never discouraged.

DISCUSSION

The rhesus monkeys of Tughlaqabad spend 20% of their waking hours in the trees and the rest 80% on the ground, i.e., in the fort, its surrounding pastures and cultivated fields and around the tomb. About 17% of the day-time is spent in active foraging for food and 3.3% for water. The time spent on foraging on a particular day depends upon the availability of food from visitors. For instance, when food is provided in abundance by visitors, monkeys spent more time on other activities and when there were too few visitors to offer the food then the time spent on other activities decreased, as they spent more time on foraging. Southwick (1962) found that rhesus spent approximately 10% of their waking hours in feeding, based on his study of the temple population in Aligarh. Altmann (1962), on the other hand, in his study of rhesus

macaques reports that a maximum of 80% of their time is spent on foraging, which is far higher than 17% of Tughlaqabad monkeys. The time spent on feeding at Maroth is almost the same as that of the Tughlaqabad monkeys (Ojha 1982).

The activities of rhesus of Tughlaqabad are governed by one major component of the ecosystem, namely, the human population. In light of the above, it would not be wrong to support the theory of Shukla, Seth and Seth (1982) that pattern of activities are based on the components of ecosystems. Presuming that the components of ecosystems affect the various behaviours, it is understandable why the results/findings of the present study are different from others.

Tughlaqabad monkeys are known to have rejected all types of nonvegetarian food except eggs which they steal from food baskets brought by picnickers. Koford (1965a), during his study of an island colony of rhesus monkeys, reported the animals frequenting bird's nests, but there are no other instances reported of the monkeys eating eggs. Lindburg (1971), on the other hand, noted the rhesus monkeys in the forest of Dehra Dun ate termites, grass hoppers, ants and beetles. Rhesus juveniles were observed eating earth in small quantities on at least seven different occasions during this study. Blanford (1888-91), Roonwal (1956), Mandal (1964), Mukherjee and Gupta (1965), Lindburg (1971), Puget (1971) and Krishnan (1972) have reported rhesus eating earth frequently in their studies though they do not mention any particular age or sex class. Yet during this study, it was specifically noted that the earth-eating animals were juveniles less than 2 years of age. This did not occur during any particular month or season but was observed at different times of the year. Though a monkey was observed eating bird droppings, no record of such a habit has been reported

by others. Since this was observed on only one occasion, it was difficult to determine the reason.

During the summer months rhesus monkeys have been observed drinking water even at 6 A.M., that is, shortly after waking up, followed by drinking at least 4 or 5 times a day from rain puddles or nala in the field area. Mukherjee (1969) observed the rhesus monkeys of U.P. to drink stagnant water 2 or 3 times a day from the roadside ditches. On the other hand, rhesus monkeys in the mangrove forest studied by Mandal (1964) were never seen drinking water. According to Mukherjee and Gupta (1965), rhesus monkeys of mangrove forests obtained water by licking dew from leaves, by eating succulent leaves and long juicy blades of grass. The rhesus monkeys of Tughlaqabad met their water requirements in a similar way. Oppenheimer (in press) in his study of *Presbytis entellus* reported 68 plant species eaten by two troops over a period of 19 months in Jalaghata and Apurbapur Study area. Whereas in Tughlaqabad only 45 plant species comprised the diet of the

monkeys. Besides, they also got a major portion of their diet from cooked human foods.

It has been observed that though the monkeys eat eggs, but perhaps due to some inner sense they do not eat meat even when offered. Because the rhesus monkeys obtain food often from the visitors or else from the natural vegetation they perhaps never had the necessity to eat insects and ants etc.

The eating of earth at all times of the year is a phenomena that is not easily explained. There seemed to be no particular reason for the animals to be eating earth. One thinks of hunger, but it is already evident that food is in abundance and such drastic measure need not be adopted to satisfy it. Likewise, earth eating is observed in young children as well, the rhesus monkeys observed eating earth were juveniles, this could perhaps be due to their playful mood, or to some special nutritional need.

The animals under study were healthy and well fed. As a consequence, only two cases of sick individuals have been observed during the entire study.

REFERENCES

- ALTMANN, S. A. (1959): Field observations on a howling monkey society. *J. Mammal.* 40: 317-330.
- ALTMANN, S. A. (1962): A field study of the sociobiology of rhesus monkeys. *Ann. New York Acad. Sci.* 102: 338-435.
- ALTMANN, S. A. & ALTMANN, J. (1970): Baboon Ecology. *Bibl. Primatol.*, No. 12. Basel, S. Karger and Univ. Chicago Press.
- BAJRACHARYA, A. N. (1979): Feeding behaviour of the rhesus monkey in Swayambhu. Ph.D. Dissertation, Trichandra campus, Tribhuvan University.
- BLANFORD, W. W. (1888-91): The Fauna of British India including Ceylon and Burma. *Mammalia*, London: Taylor and Francis.
- CHALMERS, N. R. (1968): The social behaviour of free living mangabeys in Uganda. *Folia Primatol.* 8: 263-81.
- CLUTTON-BROCK, T. H. & HARVEY, P. A. (1976): A statistical analysis of some aspects of primate ecology and social organization. Paper presented at the International Primatological Society meeting, Cambridge, England.
- COELHO, A. M. JR. (1973): Socio-bioenergetics and sexual dimorphism in Primates. *Primates* 15 (2-3): 263-269.
- CROOK, J. H. (1966): Gelda baboon herd structure and movements. A comparative report. *Symp. Zool. Soc. London*, 18: 237-258.
- (1970): The Socio-ecology of primates. *In: Social Behaviour in Birds and Mammals*, Ed. J. H. Crook. Academic Press, New York, pp. 103-166.
- DE VORE, I. & HALL, K.R.L. (1965): Baboon ecology. *In: Primate Behaviour. Field Studies of*

Monkeys and Apes, Ed. I. De Vore, Hole, Rinehart and Winston. Inc. New York, pp. 20-52.

DITTUS, W.P.J. (1975): Population dynamics of the toque macaque (*Macaca simica*). In: Socioecology and psychology of primates, Ed. R. H. Tuttle. Mouton, The Hague. pp. 125-151.

————— (1977): The social regulation of population density and age distribution in the toque monkey. *Behaviour*, 63: 218-322.

GABOW, S. L. (1973): Dominance order reversal between two groups of free-ranging rhesus monkeys. *Primates*, 14: 215-223.

GOODENOUGH, F. L. (1928): Measuring behaviour traits by means of repeated short samples. *Jour. Jur. Res.*, 12: 230-235.

HALL, K.R.L. (1963): Observational learning in monkeys and apes. *Brit. J. psychol.*, 54: 201-226.

HLADIK, C. M. & HLADIK, A. (1972): Disponibilités alimentaires et dominances vitales des primates a ceylon. *Terre vie*, 26: 149-215.

ITANI, J. (1975): Twenty years with Mt. Takasaki monkeys. In: Primate Utilization and conservation, Eds. G. Bermant and D. G. Lindburg. New York: Wiley, pp. 101-126.

ITANI, J., TOKUDA, K., FURUYA, Y., KANO, K. & SHIN, Y. (1963): The social construction of natural troops of Japanese monkeys in Takasakiyama. *Primates*, 4: 1-42.

JOLLY, A. (1972): Troop continuity and troop spacing in *Propithecus verreauxi* and *Lemur catta* at Berenty, Madagascar. *Folia primatol.*, 17: 335-362.

KOFORD, C. B. (1965a): A group relations in an island colony of rhesus monkeys. In: Primate social Behaviour., Ed. C. H. Southwick. Princeton, N. J.: D. Van Nostrand Co. pp. 136-152.

KOFORD, C. B. (1965b): Population dynamics of rhesus monkeys on Caya Santiago. In: Primate Behaviour: Field studies of monkeys and Apes. Holt, Rinehart and Winston, New York. pp. 160-174.

KRISHNAN, M. (1972): A ecological survey of the larger mammals of peninsular India, part 1. *J. Bombay nat. Hist. Soc.*, 68: 503-555.

LINDBURG, D. G. (1971): The rhesus monkeys in North India: an ecological and behavioural study. In: Primate Behaviour; Developments in Field and Laboratory research, 11, Ed. L. A. Rosenblum, New York: Academic press, 1-106.

————— (1975): Feeding behaviour and diet of rhesus monkeys in a Siwalik Forest in northern India, Unpubl. ms. 44 pp.

————— (1976): Dietary habits of rhesus

monkeys (*Macaca mulatta* Zimmerman) living in Indian forests. *J. Bombay nat. Hist. Soc.*, 73: 261-269.

LOIZOS, C. (1967): Play behaviour in higher primates: a review. In: Primate ethology, Ed. D. Morris, Chicago: Aldine. pp. 179-219.

MALIK, I., SETH, P. K. & SOUTHWICK, C. H. (1984): Population growth of free-ranging rhesus monkeys at Tughlaqabad. *Amer. Jour. of primatology*, 7: 311-321.

————— (1985): Group fission in free-ranging rhesus monkeys of Tughlaqabad, Northern India. *Int. Jour. of primatology* 4, 6: 411-421.

MANDAL, A. K. (1964): The behaviour of the rhesus monkeys (*Macaca mulatta*) in the Sunderbans. *J. Beng. Nat. Hist. Soc.*, 33: 153-165.

MARRIOT, B. (1978): A preliminary report on the feeding behaviour of rhesus monkeys (*Macaca mulatta*) in Kathmandu, Nepal. *Ann. Nepal Nat. Conserv. Soc.*, 2: 68-72.

MARSDEN, H. M. (1968): Agonistic behaviour of young rhesus monkeys after changes inducted in social rank of their mothers. *Anim. Behav.*, 16: 38-44.

MARSDEN, H. M. (1969): Dominance order reversal of two groups of rhesus monkeys in tunnel-connected enclosures. Proceedings of the Second International Congress of Primatology (Atlanta 1968), 1: 52-58.

MUKHERJEE, A. K. & GUPTA, S. (1965): Habits of the rhesus *Macaca mulatta* in the Sunderbans, 24 parganas, West Bengal. *J. Bombay nat. Hist. Soc.*, 62: 145-146.

MUKHERJEE, R. P. (1969): A field study on the behaviour of two roadside groups of rhesus macaque (*Macaca mulatta*) in northern Uttar Pradesh. *J. Bombay nat. Hist. Soc.*, 66: 47-56.

NEVILLE, M. K. (1968): Behavior of rhesus monkey in a town of northern India. *Amer. J. Phys. Anthropol.* 29: 131.

OJHA, P. R. (1982): Population trends of rhesus monkey (*Macaca mulatta*) at Maroth primate Research Centre. Paper read in Symposium on National primate programme Organised by primatological Society of India.

OPPENHEIMER, J. R. (in Press): Effects of intra and interspecific competition and habitat structure on use of time and space by Hanuman langur (*Presbytis entellus*). *Primates*.

PIRTA, R. S. (1984): Co-operative behaviour in rhesus monkeys (*Macaca mulatta*) living in urban

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and forest areas. In current primate Researches. Jodhpur: University of Jodhpur. pp. 271-283.

PUGET, A. (1971): Observations sur le macaque rhesus *Macaca mulatta* on Afghanistan. *Mammalia* (Paris), 35: 199-203.

ROONWAL, M. L. (1956): Macaque monkey eating mushrooms. *J. Bombay nat. Hist. Soc.* 54: 171.

ROWELL, T. E. (1967): A quantitative comparison of the behaviour of a wild and caged baboon group. *Anim. Behav.* 15: 499-509.

ROWELL, T. E. (1972): Female reproductive cycles and social behaviour in primates. *Adv. in the study of Behav.* 4: 69-105.

SHRESTHA, J., MALLA, Y. K. & MAJUPURIA, T. C. (1980): Rhesus monkey. In: 'Wild is Beautiful' introduction to the fauna and wild life of Nepal. Ed. T. C. Majupuria. pp. 388-399.

SHUKLA, A. K., SETH, P. K. & SETH, S. (1982): The ecology of free-ranging rhesus monkeys (*Macaca mulatta*) in an arid forest of India. In Symposium on national Primate Programme, by primatological Society of India. Abstract.

SIDDIQI, M. F. & SOUTHWICK, C. H. (1980): Feeding behaviour of rhesus monkeys (*Macaca mulatta*) in the north Indian plains. *Proc. Calcutta*, 31: 53-61.

SMITH, C. C. (1968): The adaptive nature of social organization in the genus of tree squirrels *Tamiascinrus*. *Ecol. Monogr.* 38: 31-63.

SOUTHWICK, C. H. (1962): Patterns of inter-group social behaviour in primates, with special reference to rhesus and howling monkeys. *Ann. NY Acad. of Sci.*, 102: 436-454.

STRUHSAKER, T. T. & OATES, J. F. (1975): Comparison of the behaviour and ecology of red colobus and black and white colobus monkeys in Uganda: A Summary. In: *Sociology and psychology of primates*, Ed. R. H. Tuttle, The Hague: Mouton. pp. 103-123.

TAYLOR, H. G. (1975): Cited from Majupuria, T. C., 1979-80.

TEAS, J. H. (1978): Ecology and behaviour of rhesus monkeys in Kathmandu, Nepal. Ph.D. Dissertation. John Hopkins University.

VESSEY, S. H. (1968): Interaction between free-ranging groups of rhesus monkeys. *Folia primatol.*, 8: 228-239.

ZIMMERMAN, R. R., WISE, L. A. & STROBEL, D. A. (1973): Dominance measurements of low and high protein reared rhesus macaques. *Behav. Biol.*, 9: 77-84.